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Roy Reider (1914-1979)

SELECTIONS FROM HIS WRITTEN AND SPOKEN WORDS

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On Chemical Criticality Control[1]

The aspect of nuclear energy which introduced seemingly a totally new kind of risk to the world is the prompt critical process. Here one presumably, by establishing a certain combination of mass and dimension modified in a lesser way by other parameters and provided with the omnipresent neutron as an "ignition" source, could induce damage to people and things. It appears that it is the inevitable appearance of the "igniting" neutron that makes criticality so unique a risk.

Actually in the realm of chemistry, particularly with high energy compounds, one can also find a mass/dimension influenced risk with an ignition source inherent in the process.

With high energy compounds, safety controls are exercised as successfully by avoiding critical mass and dimension as by avoiding ignition sources.

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Low or deflagrating explosives can be made to burn when ignited by flame or spark. Their burning rate can be speeded up by increased temperature and pressure which is typical of chemical reactions in general. This pressure/temperature enhancement of reaction rate can rapidly produce a transition from deflagration to detonation.

The transition of orderly burning to high order detonation can be entirely mass related or associated with a critical dimension such as column height. Hence the destructive potential of low explosives in the accidental explosion of large quantities is little different than high explosives. This chemical criticality risk can be best illustrated by the Texas City disaster of 1947. Here two large order explosions occurred in a very insensitive explosive, ammonium nitrate. Conditions prevailed where the charge masses exceeded a certain critical value.

One of the most hazardous operations within the explosive industry is the disposal of unwanted explosives materials. A common technique is destruction by burning. The problem of critical dimension in this operation is recognized by the specific limiting requirement for high explosives burning beds to be no more than 3 inches deep. Other substances have different depth limits: smokeless powder 6 inches, and dynamite 2 inches.

On the Fundamentals of Safety[2]

Let me delineate the fundamentals of safety.

Management leadership in the declaration of policy and assumption of responsibility for control of accidents.

2. Assignment of responsibilities to operating officials, safety and health personnel, supervisors, and technical committees.
3. Establishment of requirements for procedures, including review of procedures.
4. Maintenance of safe working conditions, including inspections by specialists (of cranes, elevators, high-pressure equipment, fire protective devices, etc.), committee inspections, proper purchasing and acquisition, supervisory interest, and other elements.
5. Safety training for supervisors and employees which could include first aid, emergencies, review of accidents, technical information, protective clothing, safety fundamentals, and a variety of specific subjects.
6. Medical and first aid: preplacement and periodic examinations, treatment of injuries, and health counseling.
7. A system for reporting and recording accidents, including near misses or potential mishaps, which can alert personnel concerned to needed protective measures or procedural changes.

On Policy and Responsibility [2]

The most important fundamental in the prevention of accidents is the assignment and the acceptance of responsiblity wherein people at any level of supervision or in staff assignments say readily, "Not only has this been assigned to me as an individual but also I avow that, if anything goes wrong in the operation with which I have been associated or assigned, come see me." This acceptance of responsibility seems universally to be rapidly fading away from the functions of modern administration, and this is unfortunate.

I emphasize that the most important fundamental is the assignment and acceptance of responsibility. This responsibility must be accompanied by the authority and resources that are commensurate with the degree of responsiblity expected.

Fifteen years ago at the laboratory where I worked there was a series of devastating explosions. These mishaps cost the lives of 6 employees and left 28 fatherless children. The most common deficiency leading up to these accidents was the lack of appropriate operating procedures.

When I spoke to people, some of my own people, reminding them how remiss we had been in the steps available to avoid these catastrophies, they said, "Oh, you asked them to have procedures; twice you asked them to have procedures." I could have done this 40 times and still have been remiss because I had not yet exhausted all the resources available to me to prevent these mishaps. If you stand somewhere in the chain of responsibility for the performance of people and you have not exhausted all your resources, you share responsibility, you should accept responsibility, for what goes wrong. The more you obsess yourself with this idea, the less are the chances, I believe, that accidents will occur. Supervisors closest to the operations being performed, those in the first level of supervision, those closest to the employees carrying out the procedures, must have the assigned responsibilities. Accepting this, they can proceed to carry out the elements of a program necessary to control accidents. The management chain above the supervisors shares this safety responsibility, perhaps in a more limited way, but clearly their support is required in the many elements of the safety program: reiteration of policy, provision of resources, and the willingness to exert a heavy hand.

We start off here with management leadership and the importance of assigned responsibility. It is very simple when management says, "This is our establishment. We propose to proceed in a certain way. We want a certain level of safety." These cannot be left to words, however. In one of his King Henry works, Shakespeare, speaking of the king walking among the troops on the night before battle, used the phrase "a little bit of Henry in the night." Management leadership as a policy which is printed on a piece of paper to give out to new employees or which is recited by the personnel people to a new employee during orientation is great. But this consists only of words. It cannot be left at words; it requires not only management policy but also leadership--and participation. If safety is left entirely to the safety people to accomplish, it is going to be inadequately, poorly, and sometimes ineptly done. When management participates in as well as expresses a policy, doing more than merely making statements, an important step is taken toward safety.

On Written Procedures[2]

The more hazardous an operation, the more necessary it is that there be a procedure thought out ahead of time and checked by competent higher authority, not by remote authority but by close and competent authority. The more hazardous the operation, the greater is the need for the procedure that is expressed by the people who do the work, reviewed by people who are competent in the work, and endorsed by higher authority. Let us substitute now for the word "hazardous" -- because, in view of the history of nuclear energy and the history of nuclear safety, by no stretch of the imagination can we say that criticality is fairly characterized as a high risk. We can substitute for the word "hazardous" the word "sensitive," the words "operation that can create tremendous public reaction," or the word "expensive." So, wherever we have an operation that can be characterized by these extremes--the extremes of hazardous, expensive, or causing severe public reaction--very real reason exists for procedures that are thought out, reviewed, and approved. Although these procedures have been done in a thoughtful and considerate fashion, they were not given to us as though from Mt. Sinai, engraved in stone. They were procedures created by man. Therefore they require a follow-up on a periodic or a nonperiodic basis so long as the procedures are viable. There are many means for us to find our way to the proper path. There is not just one way. I feel no great concern about consistency or conformity. Procedures should be looked at, reviewed, tested, checked, etc.

On Profiting from Accidents[3]

As accidents are rarely Acts of God competent investigations will show errors of omission and commission which must be corrected if indeed any good is to come of an untoward event.

The second greatest tragedy of an accident is the failure to profit from the loss, the failure to improve, the failure to make the future less likely to see a recurrence of the same or similar accidents. Thus it is indeed seemly for accidents to be carefully examined, to be discussed in detail and to intrude prominently in our future actions.

. . .

A new technology may introduce a new risk, or combinations and enhancement of old risks, but such risk lessens as the development of the technology results in new knowledge. Publication and use of accident information is an important element of that knowledge.

On Safety Training[2]

Safety training for a new employee is often started within an organization in a "new employee orientation program." This program is usually carried out by the personnel department, and perhaps the safety and health departments participate. These are good programs, and they are helpful to the supervisor by relieving him of many administrative details. I play a role in these programs myself. I do not turn this responsibility over to the personnel department, because I feel I do it better and that I should do it. Still, what I do in safety orientation for the new employee is not nearly so important as what the supervisor can do to impress the new employee. The supervisor is closer to the employee and to the operation and can make the strongest impression on the new employee.

On Early History of Criticality Safety[4]

ABSTRACT

Four of the earliest critical assemblies involving enriched ^{235}U are described. The safety procedures employed for them are discussed in detail.

The Water Boiler. A uranyl sulphate solution was remotely air-pumped from an ever-safe vessel into the reactor sphere above.

The Dragon Experiment. The reactor was constructed so that a slug dropped through an assembly (both of active material) gave a divergent chain reaction lasting for 1/1[illegible] sec and supported by prompt neutrons alone. An ingenious mechanical structure with multiple safety devices and interlocks gave a high degree of safety to the experiment.

The "Drop-Leaf" Assembly. A hydrogenous reflector in the form of paraffin slabs was stacked around an enriched uranium assembly; part of the reflector was built upon a hinged leaf supported by a prop that could be displaced electrically or by hand, using a long cord.

The Movable-Table Assembly. A critical assembly was divided between a stationary table and a movable table that could be remotely manipulated to achieve criticality. Several independent safety devices could disassemble the active material in case of high radiation or utility failure.

Conclusions are drawn from comparison of these well-planned experiments with the early hand-assembly accidents.

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Conclusions

Any history of safety usually recognizes the enormous influence that accidents have on the safety standards and procedures employed thereafter. Actually, the Water Boiler critical assembly and the Dragon experiment were carried out before the early hand-assembly fatalities, and the Snell hinged-table experiment was conceived before the first hand-assembly accident. The Oak Ridge experiment by Beck and his coworkers followed the first hand-assembly fatality and may have been influenced by that accident.

The two fatalities from direct-observation accidents have been described in the literature. These incidents should be of only historic interest now because the techniques employed then would not even be considered today. However, there are powerful lessons to be learned from the early history of criticality safety as well as the early history of criticality accidents. Experiments thought out ahead of time and subject to discussion between the experimenters and their principals, a procedure to be prepared by the person doing the work and reviewed by higher authority competent in the nature of the work, and a test of equipment and procedures under "inert dry run" or "dummy" circumstances: these are the elements of safety. On the other hand, actions of individuals without sufficient training or practice, supervision of direction, procedural control or review, give much less assurance of safety.

On Requirements for the Possible[5]

Despite the introduction of risk from new technologies, society tends to become safer. Any new risk tends to be reduced as the technology becomes more widely used, or, conversely, new technologies may have to prove their safety before full acceptance.

A typical, if somewhat extreme, example is regulation concerning permissible occupational exposures to ionizing radiation. During the early years of this century the dangers of radiation were recognized. However, only qualitative standards were used. "If the individual showed reddening of the skin, he has received too much."

In the 1920's the first limits were set by a national body at 100 rem per year. In 1934 this limit was reduced one-third by an international body and reduced two-thirds by a United States regulation. In 1950 the international standard permissive dose was down to 15 rem per year. Before the decade was over, this was further reduced two-thirds and is today at 5 rem per year. Even with this relatively low permissible limit, the number of workers exposed who approach the allowed level is only a few percent. . . .

While one might fairly argue that this exaggerated reduction is an enormous effort for a small gain in safety, it does reflect the public desires and concern for exotic risk.

This dramatic change in safety level was accomplished by regulation, by direction, by state-of-the-art improvements, and by realization that things ought to be and could be done more safely -- in other words, by challenge and reexamination of work methods.

In the matter of safety standards for avoiding hazards of ionizing radiation we begin to see what I will call henceforth "a requirement for the possible."

On the Value of Enlightened Challenge[5]

Safety thrives on challenge--challenge not for its own sake, but challenge for the need to reexamine the work environment and work methods.

While it is not always clear that something can be made absolutely safe it is generally certain that an environment or a procedure can be made safer.

Challenge works in both directions. Changes suggested in the name of safety should be able to withstand challenge.

Is the regulation or recommendation, existing or new, relevant to risk? Is the cause of accident prevention served by the expense or effort? Or can safety be better served by emphasis on other priorities of occupational risk?

Authority alone will not create truths. Regulations bearing the endorsement only of governmental bureaus will be less likely to find useful acceptance than the historic consensus standards. Of course, many of the voluntary consensus standards were written as guides rather than as regulation with the force of law. I believe OSHA has generally used these effectively and in relation to risk. Only continuous and enlightened challenge with insistence on relevancy to risk will avoid a numbing encroachment by a too powerful executive branch which can lose its sense of mission and become self-serving without that challenge.

On Public Acceptance of a New Risk[6]

My observations on the public acceptance of new risk leads me to conclude that an understanding of the nature and consequences of potential misadventure may be as important as an accident-free experience. Too often does one see the concept of "maximum credible accident" become like the childhood boast of "my daddy can lick your daddy" or "I can figure out a credible accident more maximum than yours." Soon it is the credibility that gets strained and once this begins it is like yearning for the superfluous - without limit and of little use.

At the other end of the numbers spectrum in consideration of risk one finds the groping towards zero. While there is good agreement, at least at the technical if not the political level, that zero risk cannot honestly be claimed, nevertheless one finds again this competition for an unassailable position so close to zero that the difference is not real. To phrase the viewpoint "I can think of a negative exponent which is a larger integer than yours." Recently in a reactor failure analysis I came across a risk alleged to be 10^{-15}; I freely confess an inability to comprehend such a number.

On Prophets of Doom[7]

With the increased social awareness of risk in recent years has been the parallel development of the "prophets of doom." These are the individuals and groups who view science and technology as plunging ahead, guided only by their own internal value systems, applying new knowledge hastily without regard to human and esthetic consequences. In the force of this advance, according to the usual indictments, the individual is almost helpless. There is little doubt of the truth in the accusation that science and technology have introduced new risks. I believe it is equally true that there has been a historical gain in safety through technical changes. To interrupt this gain by a demand for a demonstration of absolute safety would be a tragedy which I hope we could avoid.

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